Highlights from a Decade of OMI-TOMS Total Ozone Observations on EOS Aura

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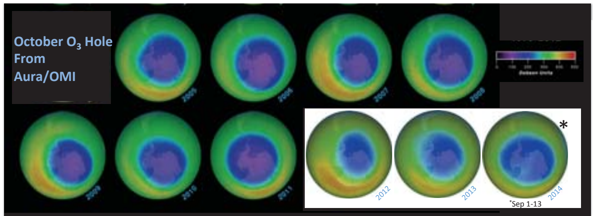
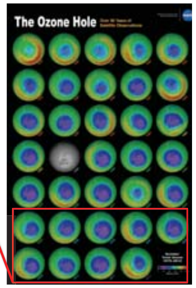
Abstract

Total ozone measurements from OMI have been instrumental in meeting Aura science objectives. In the last decade, OMI has extended the length of the TOMS total ozone record to over 35 years to monitor stratospheric ozone recovery. OMI-TOMS total ozone measurements have also been combined synergistically with measurements from other Aura instruments and MLS in particular, which provides vertically resolved information that complements the total O3 mapping capability of OMI. With this combined approach, the EOS Aura platform has produced more accurate and detailed measurements of tropospheric ozone. This has led in turn to greater understanding of the sources and transport of tropospheric ozone as well as its radiative forcing effect. The combined use of OMI and MLS data was also vital to the analysis of the severe Arctic ozone depletion event of 2011. The quality of OMI-TOMS total O3 data used in these studies is the result of several factors: a mature and well-validated algorithm, the striking stability of the OMI instrument, and OMI's hyperspectral capabilities used to derive cloud pressures. The latter has changed how we think about the effects of clouds on total ozone retrievals. We will discuss the evolution of the operational V8.5 algorithm and provide an overview and motivation for V9. After reviewing results and developments of the past decade, we finally highlight how ozone observations from EOS Aura are playing an important role in new ozone mapping missions.

Is the Stratospheric Ozone Layer Recovering? (in maps?)

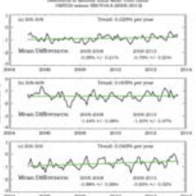


2005-2014



Hard to impossible to tell from these figures, but they communicate an important story.

OMI is a mapping instrument, and while extension of the total O_3 record is a main goal of OMI , for NASA the recommended total O3 column long-term dataset is SBUV total O_3. But OMI-TOMS data quality is very good as well. The figure to the right compares OMI-TOMS and SBUV(/2) total ozone data.



"…in a rare piece of good news about the health of the planet." – AP

Assessment for Decision-Makers

Scientific Assessment of Ozone Depletion: 2014

"There are indications of an increase in global-mean total column ozone over 2000–2012, consistent with model predictions."

Fragile ozone layer shows first sign of recovery - U.N.

Source: Reuters - Wed, 10 Sep 2014 19:44 GMT

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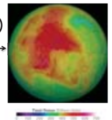
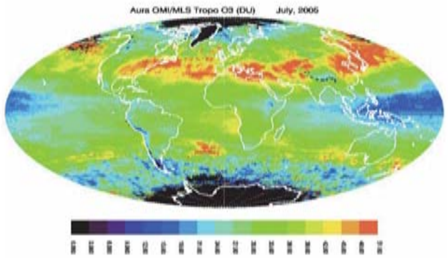


April 1, 2014

Tropospheric O_3 Applications



Tropospheric column ozone is determined using the tropospheric ozone residual method which involves subtracting measurements of MLS stratospheric column ozone (SCO) from OMI total column ozone after adjusting for intercalibration differences of the two instruments using the convective-cloud differential (CCD) method.

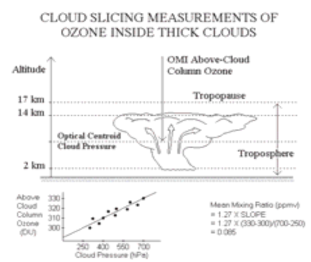


Fig. 4. Schematic diagram illustrating the ensemble cloud-slicing method. The figure shows that a satellite UV instrument is sensitive to the O_3 column from the top of the atmosphere down to the OCCP altitude which may lie several hundred hPa below geometrical cloud top. The lower half of the figure illustrates that using an ensemble of such measurements over a fixed region, mean volume mixing ratio can be determined from the slope of column O_3 plotted versus OCCP.

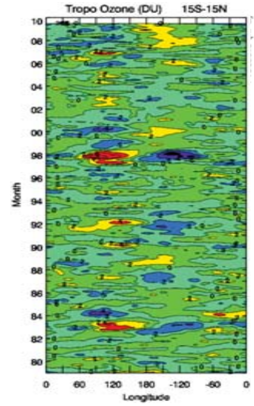
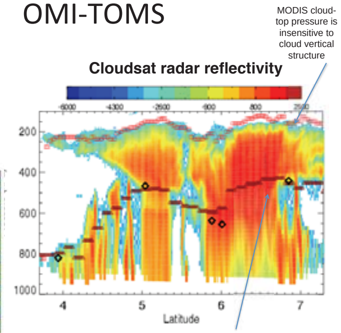


Fig. 7. Time versus longitude Hovmoller diagram of monthly mean TCO (in DU) from TOMS/OMI measurements averaged between latitudes 15° S and 15° N for the period 1979–2009 (see text). The data were filtered to remove the zonal mean each month and further deseasonalized as in Fig. 3. A 3-month running average was applied. The numbers listed on the vertical axis refer to January of the particular year.

Synergy: OMI + MLS

The synergy of OMI and MLS measurements has been particularly advantageous to the study of both tropospheric and stratospheric ozone processes. Differential sensitivity among these two instruments on the same platform have made Aura an excellent orbiting O3 laboratory.

Clouds pressures used in OMI-TOMS



Cloud Optical Centroid press calculated using OMI-measured Rotational Raman Scattering is sensitive to cloud vertical structure (Vasilkov *et al.*, JGR, 2008)

The optical centroid pressure of the scattering cloud layer is much higher than IR pressures assumed early versions of OMI-TOMS.

OMI Raman cloud pressures were adopted in V8.5 of the OMI-TOMS algorithm, improving tropospheric O3 results from cloud differential methods.

Arctic Depletion in 2011

The mechanism responsible for the unprecedented depletion of Arctic ozone was elucidated with the help of OMI-TOMS total ozone data, which was used to establish the magnitude of the ozone deficit. This information was used in CTM runs to help constrain possible scenarios responsible for the large depletion.

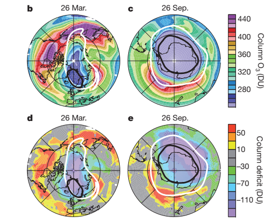
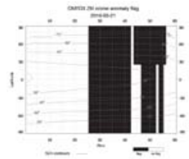
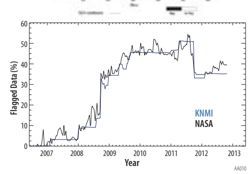


Figure 5 | Total column ozone. **a**, Time series of the fraction of 460 K vortex area with total ozone below 275 Dobson units (DU) in February–April in the Arctic (bottom axis), and in August–October in the Antarctic (top axis). Line colours/shading as in Fig. 1. 2005–2011 values are from OMI; earlier values are from TOMS (Total Ozone Mapping Spectrometer) instruments[50]. Maps show OMI total ozone (**b**, **c**) and ozone deficit (**d**, **e**) in the Arctic (Antarctic) on 26 March 2011 (26 September 2010). Overlays as in Fig. 2 but at 460 K.

OMI TOMS data quality





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